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(54) Coin handling apparatus

(57) A coin handling apparatus has a hopper to direct coins against the lower part of a rotating disc 8. Projections on the disc cooperate with an upstanding wall 9 surrounding the disc to define recesses that can each accommodate one coin. The coins in the recesses fall onto a ramp 12 adjacent the top of the disc and roll down the ramp sequentially The coins are identified and passed to appropriate outlet passages. The coins may be identified by projecting an image of a coin onto an elongate photo-sensitive device, or by detecting the phase shift created in a signal passing through a coil when a coin passes the coil.

Fig.2.

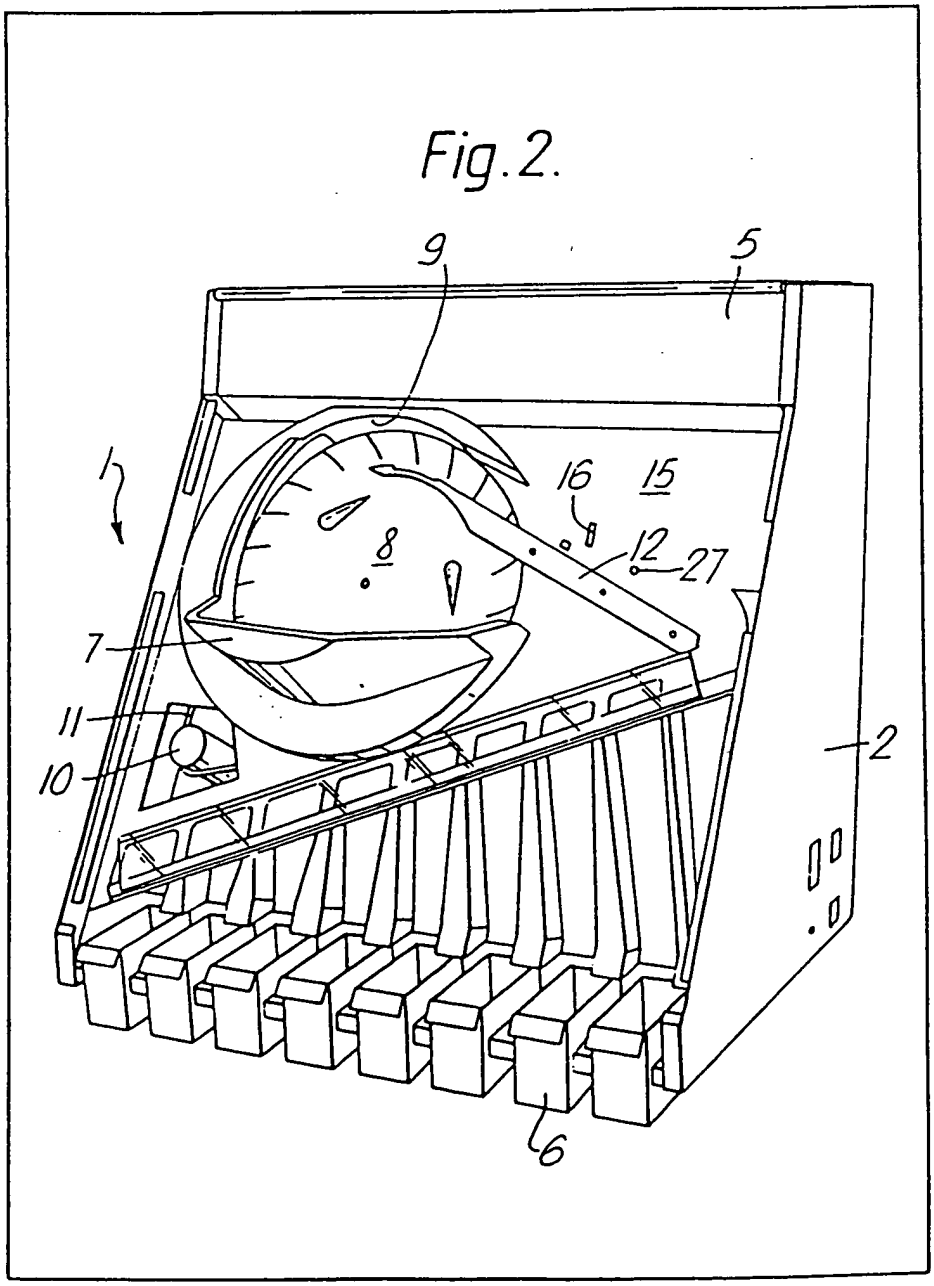

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Fig.1.

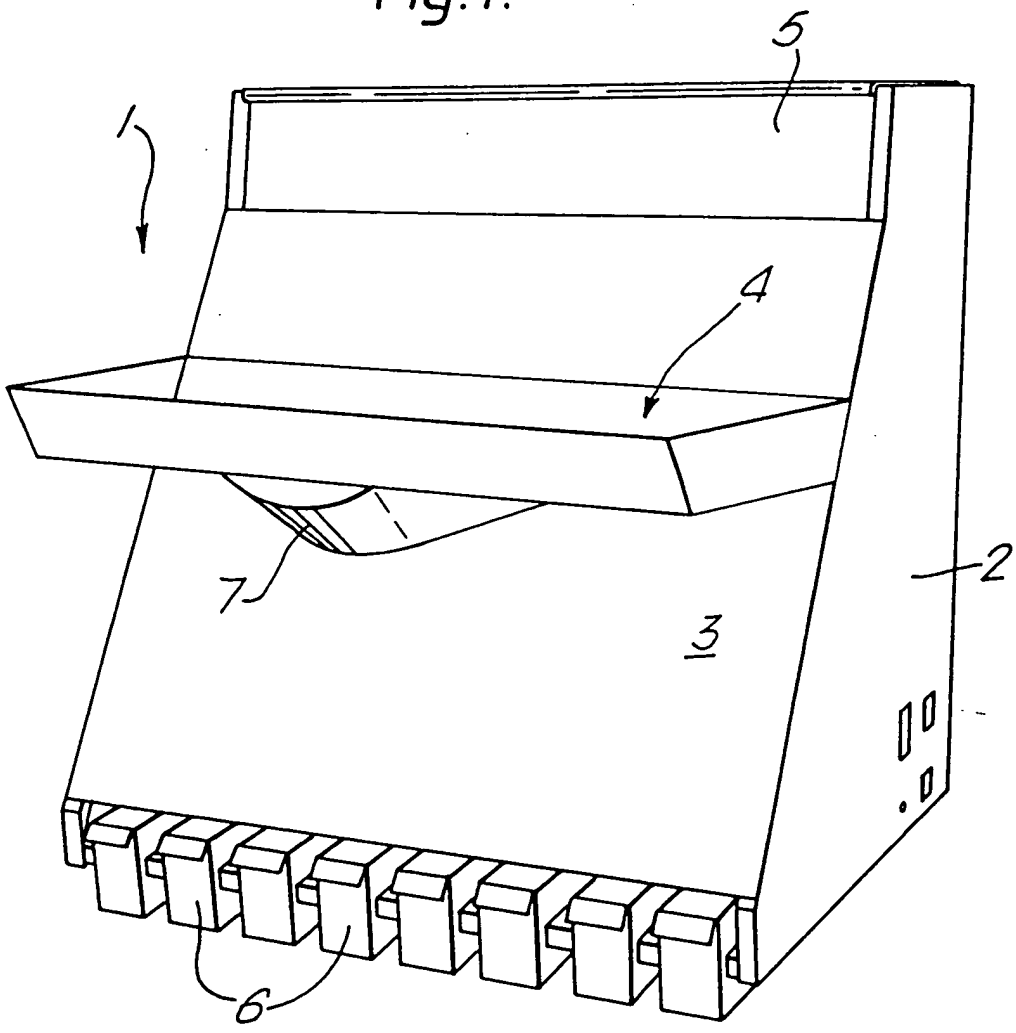

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Fig.2.

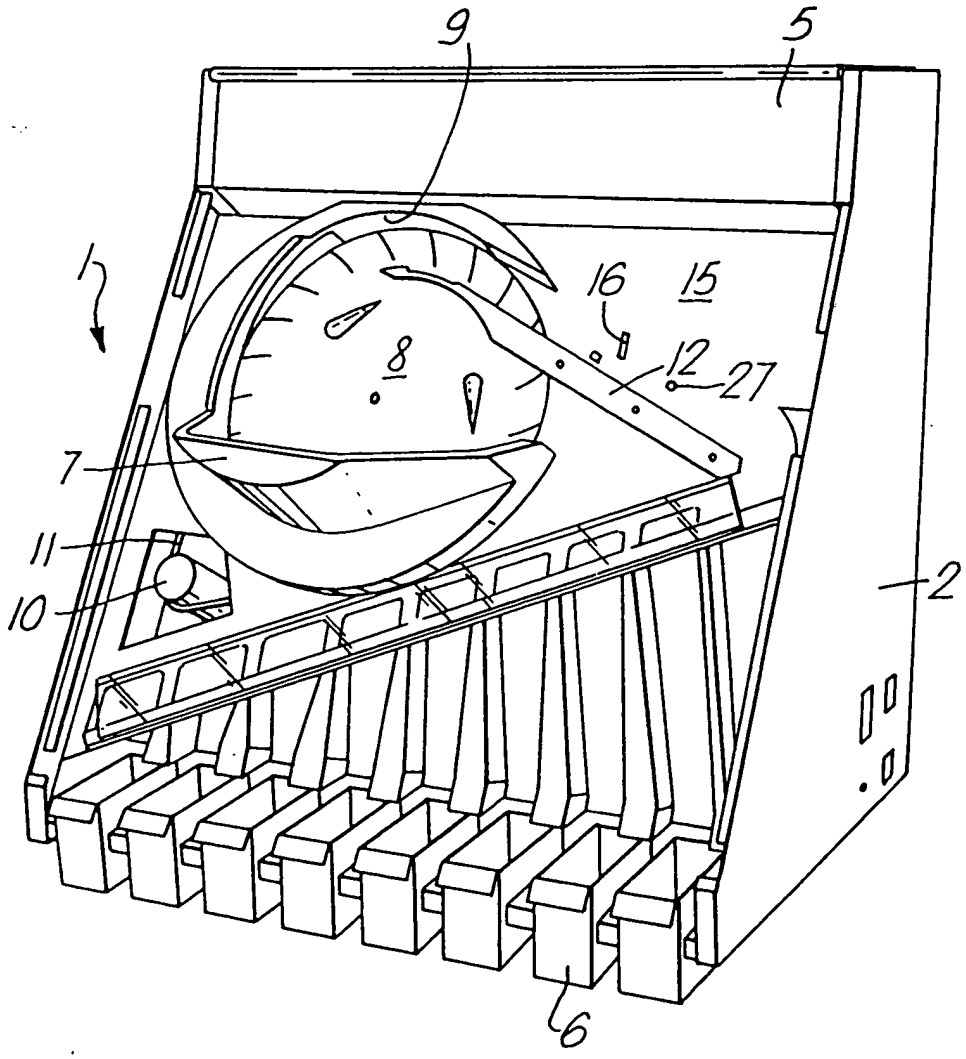

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Fig.3.

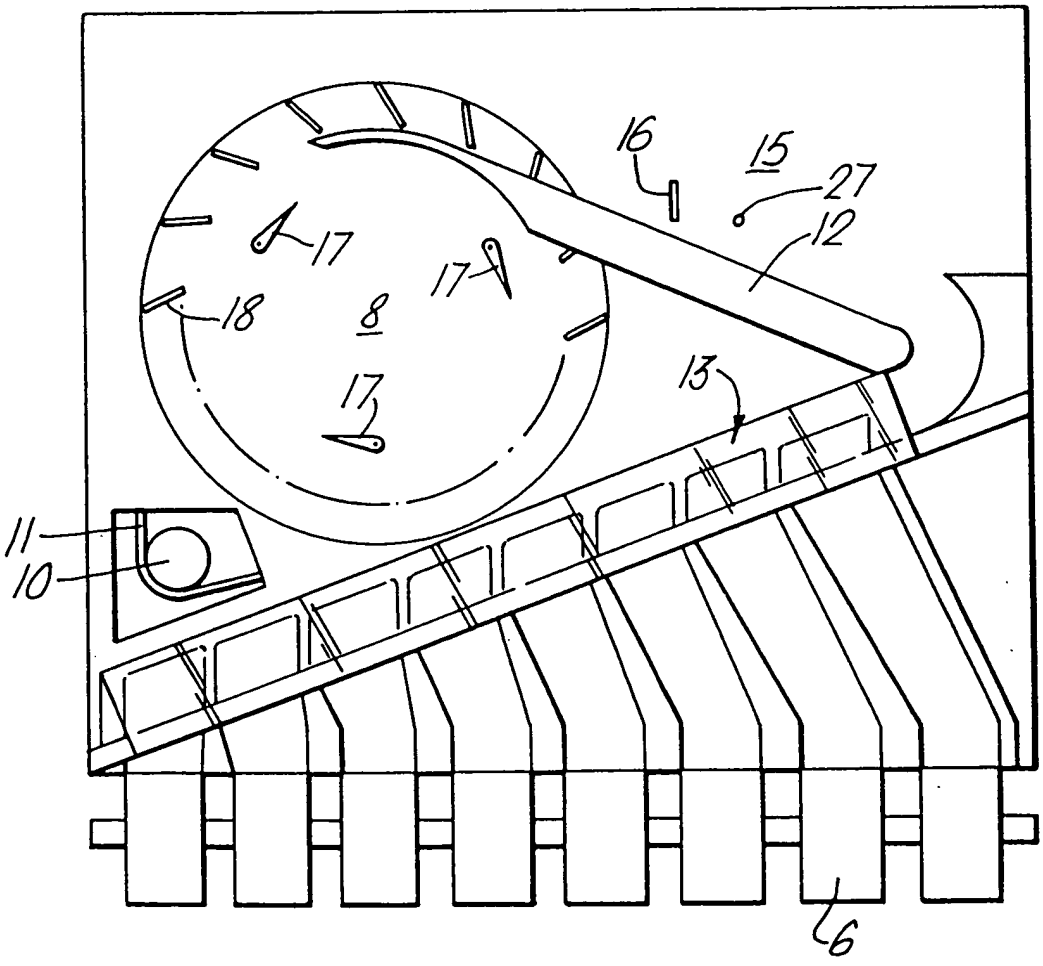

Fig. 4.

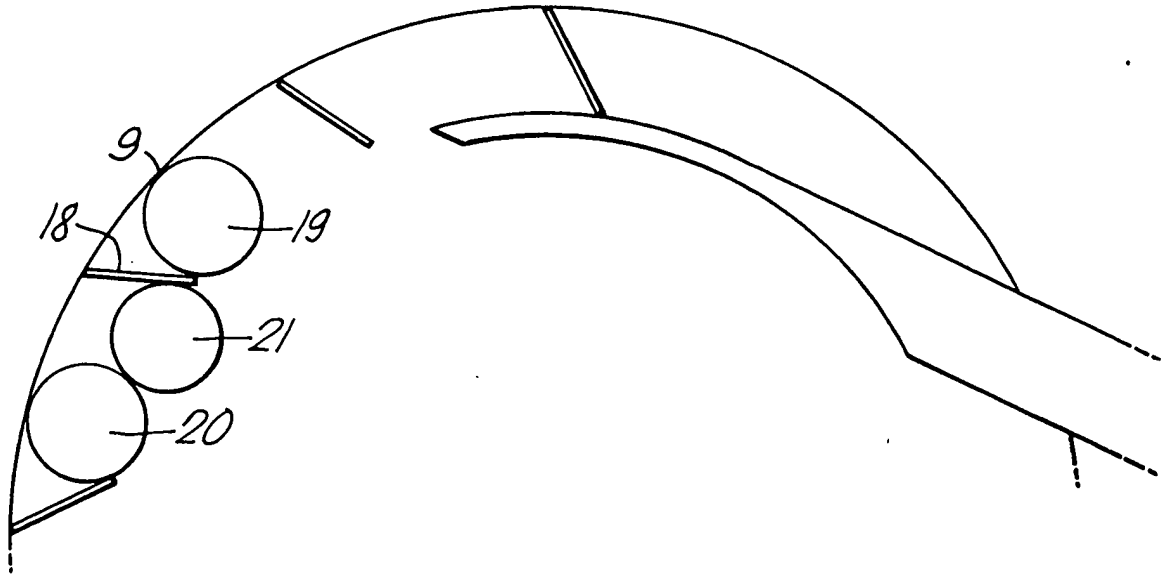

Fig. 5.

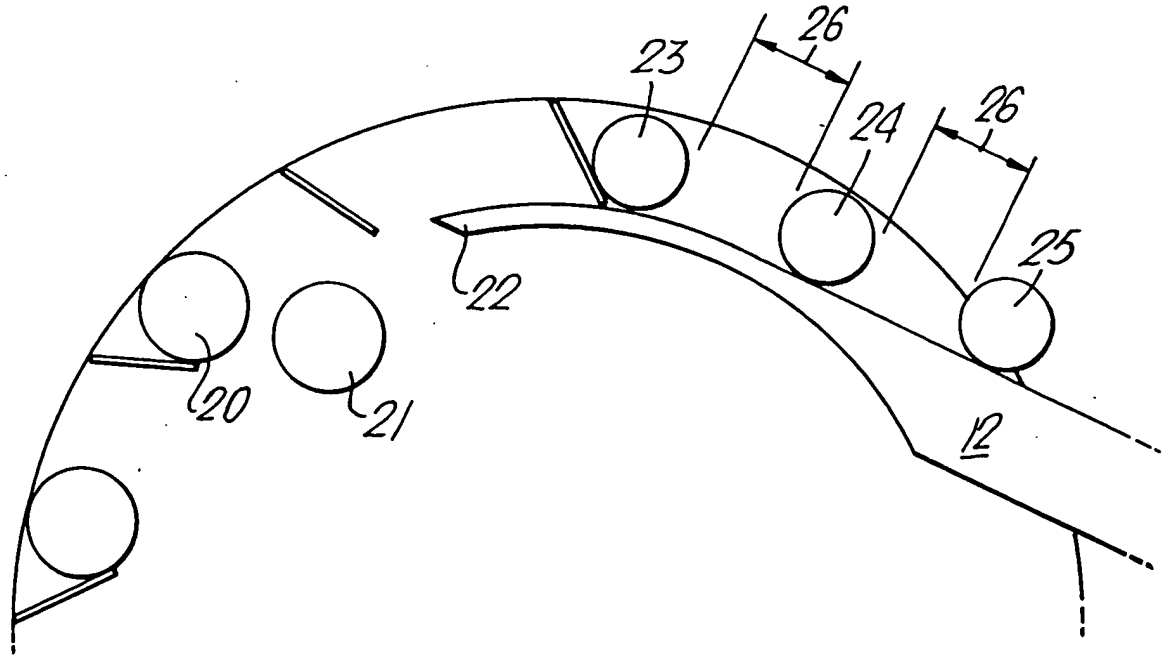

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Fig.6.

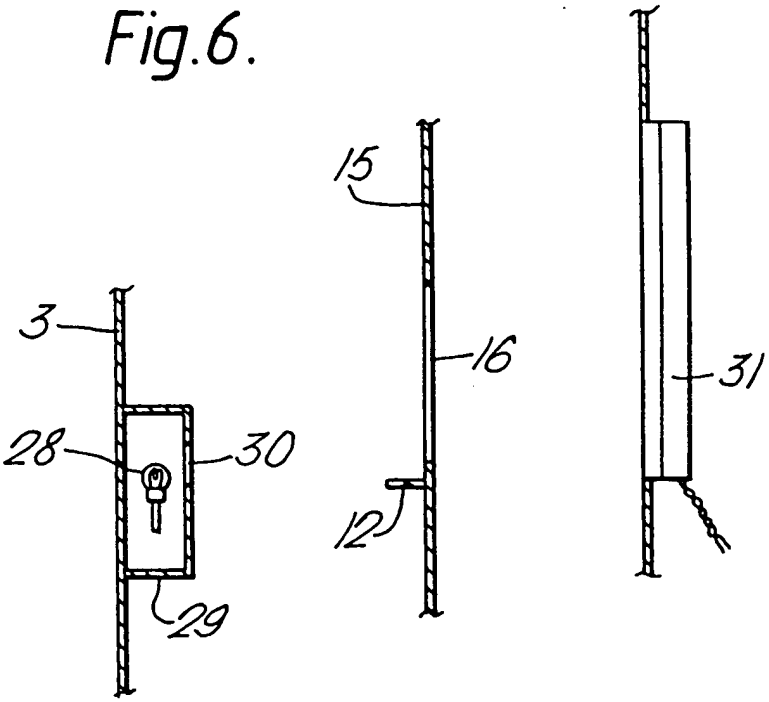


Fig.7.

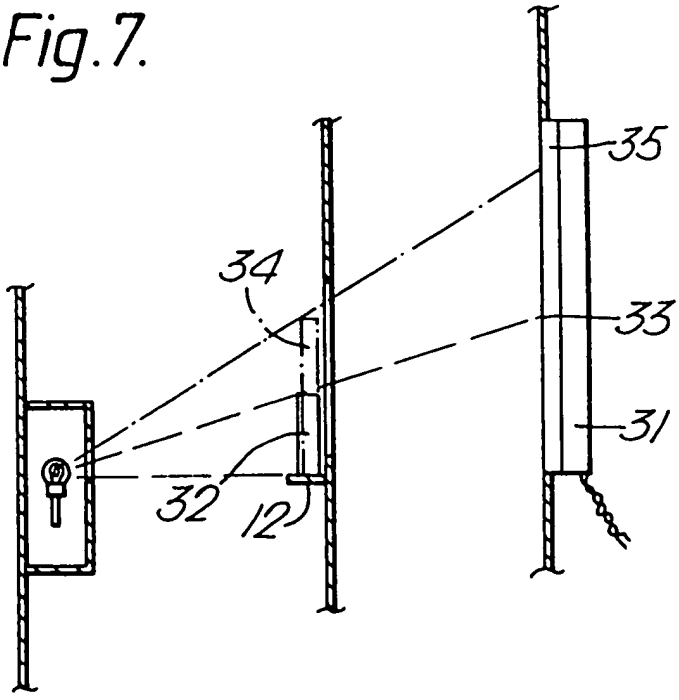
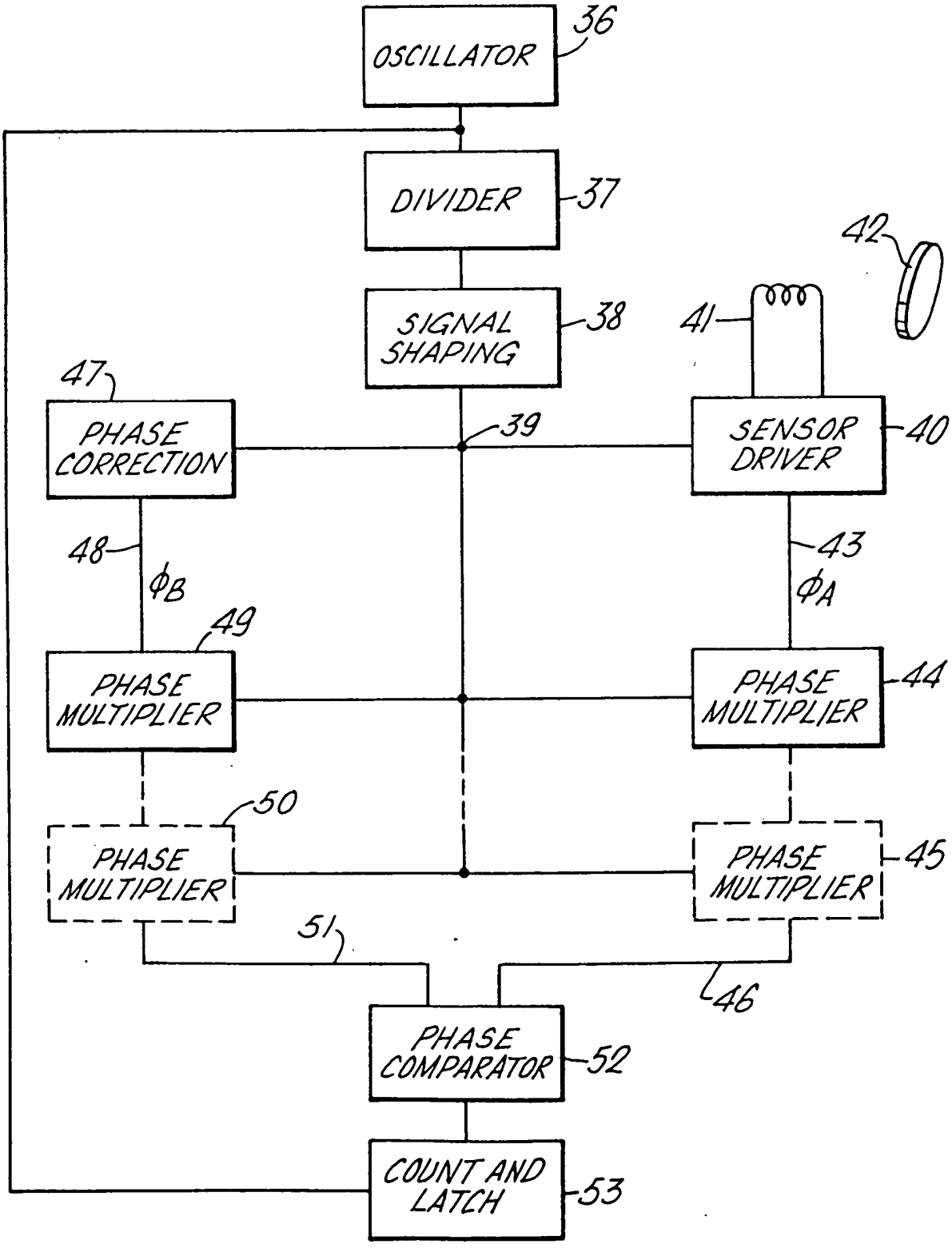


Fig.8.


OSCILLATOR
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COUNT AND LATCH
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SPECIFICATION

Improvements in or relating to coin handling apparatus

The present invention relates to a coin handling apparatus, and more particularly relates to a coin handling apparatus specifically adapted for handling a mass of coins.

According to one aspect of this invention there is provided a coin handling apparatus, said coin handling apparatus comprising means defining a substantially planar inclined face, at least part of the means adjacent the periphery of the face being movable in a rotary manner within the plane of the face, elements being provided, mounted on the said means, protruding above the said plane, there being a wall extending substantially perpendicularly to said plane immediately adjacent the outer periphery of said means, at least in a region extending past a portion of the lower part of the periphery, said movable means, elements and wall co-operating to define recesses each dimensioned to accommodate a coin, the apparatus further comprising means to direct a mass of coins to a position adjacent the lower portion of said movable means and means defining a transportation path to be followed by said coins, the arrangement being such that when the movable means move coins can become located within said recesses to be moved in synchronism with the movable means to a position in which the coins leave the recesses and follow said transportation path.

Preferably the transportation path comprises a downwardly inclined ramp, the arrangement being such that a coin present in a recess will leave the recess when the recess has moved to a predetermined position, the coin then rolling down the ramp.

It will be appreciated that the said means may comprise an inclined disc, and in a preferred embodiment of the invention the entire disc is rotatable. However it is conceivable that in one embodiment of the invention the movable means may comprise a rotatable annular member.

Preferably the ramp extends across part of the upper periphery of the said inclined face, and in such an embodiment it is preferred that each said element is resiliently mounted on said movable means to be movable between an operative projecting position and a retracted position, each element moving to a retracted position as it moves past the said ramp.

Preferably when each said element is on the operative position the element protrudes beyond the said plane by a distance which is less than or equal to the thickness of the thinnest coin to be handled.

In the presently preferred embodiment of the invention each said element comprises a substantially linear element, one end of the element being located substantially adjacent the periphery of the movable means, the axis of the element being inclined forwardly (in the sense of movement of the movable means) of the line connecting the end of the element adjacent the periphery of the movable means and the centre of movement of the movable means.

Preferably the arrangement is such that when each said recess reaches the commencement of the said transportation path only one coin can be accommodated within the recess.

In the preferred embodiment of the invention the means for directing the coins adjacent the rotating member comprise a hopper.

Preferably means are provided for determining the identity of any coin moving along said coin transportation path, the apparatus further comprising means to determine the eventual destination of a coin once its identity has been established. Thus in one embodiment of the invention the coin transportation path may lead to a portion of the apparatus including a plurality of channels leading to a plurality of outlet chutes. Each outlet chute may have a coin collecting bag mounted on it. The apparatus will thus serve to identify a coin and to direct that coin to the appropriate outlet chute. The apparatus may be controlled by an appropriate microprocessor or the like.

According to another aspect of this invention there is provided a coin handling apparatus comprising means for directing coins from a mass of coins to follow a predetermined coin transportation path, means adapted to identify a coin travelling along the coin transportation path, and means for returning a coin from the coin transportation path to said mass of coins, if the coin is not required for subsequent handling by the machine.

It is to be appreciated that with a machine of this type, a mass of coins may be introduced to the machine, and the coins may be supplied sequentially to the coin transportation path. As the coins are identified the coins may initially be fed to appropriate destinations, for example, a number of coin holding bags, each of which is to be supplied with a predetermined number of coins of an appropriate predetermined denomination. When the bag intended to hold coins of one particular denomination is full, if another coin of that denomination is detected, the coin may be returned to the mass of coins that is to be handled. Thus the coins that are no longer required will effectively be cycled back into the mass of coins each time a coin of that denomination moves down the coin transportation path.

Preferably the coin transportation path comprises an inclined ramp and the means for returning a coin to a mass of coins it comprises a solenoid operated device adapted to return a coin to a hopper or the like which is located below said ramp.

According to another aspect of this invention there is provided a coin identifying apparatus, said coin identifying apparatus comprising means defining a coin transportation path along which coins are intended to move, a light source located on one side of the coin transportation path and an elongate photosensitive device located on the

other side of the coin transportation path, but spaced away from the path, the arrangement being such that an image of each coin is projected onto the photosensitive device as the coin moves down the coin transportation path.

The use of an elongate photo-sensitive device enables the diameter of the coin to be determined accurately. Preferably the light sensitive device is a linear array of photodiodes or a linear array or matrix of fibre optic elements each directed towards a separate photodiode. Alternatively a linear photo-electric element may be used.

According to a further aspect of this invention there is provided a coin identifying apparatus, said coin identifying apparatus comprising a coil located adjacent a path followed by coins to be identified, means for applying a signal of an appropriate frequency to the coil, means for multiplying a phase shift applied to said signal by the coil when a coin is located adjacent the coil and means for determining the magnitude of the multiplied phase shift.

Preferably the apparatus comprises means for supplying a shaped signal to an appropriate circuit driving the coil and to a phase correction circuit, the output of the phase correction circuit and the circuit driving the coil being in phase when no coin is present adjacent the coil, the output of the phase correction circuit and the driver circuit being phase multiplied by a predetermined number of times, the phase multiplied signals being fed to a phase comparator.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a front perspective view of a coin handling apparatus embodying features of the present invention;

Figure 2 is a view corresponding to Figure 1 but with parts of the apparatus removed more clearly to illustrate various working parts of the apparatus,

Figure 3 is a front view of the part of the apparatus as shown in Figure 2 to illustrate more clearly various features of the invention;

Figure 4 is an enlarged diagrammatic view illustrating part of the apparatus as shown in Figure 3, illustrating one stage during the operation of the device,

Figure 5 is a view corresponding to Figure 4 showing a slightly later stage during the operation of the device,

Figure 6 is a vertical sectional view through part of the apparatus illustrated in Figures 1 to 3;

Figure 7 is a view corresponding to Figure 6 showing the illustrated part of the apparatus when in use, and

Figure 8 is a block diagram of an electronic arrangement that forms part of a preferred embodiment of the invention.

Referring initially to Figure 1 of the accompanying drawings a coin handling and sorting apparatus 1 comprises a housing 2. The housing has an inclined front face 3 from which projects a coin receiving hopper 4. At the top of the housing 2 is a panel 5 which is illustrated as being totally blank. However, in various embodiments of the invention the panel 5 may be provided with various display devices to display the numbers of coins of various denominations handled by the machine, and the total value of the coins handled by the machine during a cycle of operation. Additionally or alternatively the panel 5 may be provided with various control buttons or switches to control the operation of the machine.

Provided towards the bottom of the sloping wall 3 are a plurality of outlet chutes 6. Each chute, in the embodiment illustrated, is adapted to have a coin storage bag releasably connected to it.

To facilitate an understanding of the following description it should be mentioned, at this stage, that when the coin handling apparatus illustrated in Figure 1 is utilised, coins of various denominations will be tipped into the hopper 4. The apparatus will then operate to identify the various coins, and to transfer appropriate coins to appropriate ones of the chutes 6. Thus bags mounted on the chutes 6 will be filled to an appropriate value with coins of a predetermined denomination. As will become clear from the following description the preferred machine will be able to cope with various situations that may arise, for example a large number of coins of one denomination, which is greater than the number of coins required to be introduced to bags present on the chutes 6, and the presence of foreign coins or tokens.

Figure 2 illustrates the apparatus with the front panel 3 and the coin hopper 4 removed. A protruding funnel-like portion 7 can be seen clearly in Figure 2. This funnel-like portion, as can be seen from Figure 1, extends immediately under the hopper 4, and the hopper operates to direct coins into the funnel-like portion 7. The funnel-like portion 7 serves to direct coins towards the lower part of the front face of an inclined disc 8. The disc 8 is effectively located in a recess defined by a wall 9 that extends perpendicularly to the plane of the disc 8 and effectively surrounds the greater part of the periphery of the disc 8. Part of the funnel-like means 7 defines the region of the wall 9 that surrounds the lower part of the periphery of the disc, and an appropriate extension of the funnel-like means defines the wall 9 extending around the remainder of the periphery of the disc.

The disc 8 is adapted to be rotationally driven in a clockwise sense as shown in Figure 2 about an axis that is normal to the plane of the disc and located centrally relative to the disc. In the embodiment illustrated a motor drives a shaft 10, and a drive belt 11 is driven by the shaft 10. The drive belt 11 engages an appropriate pulley connected to the rear of the disc 8 (not shown).

As can be shown most clearly in Figure 3, which is a front view of the apparatus as illustrated in Figure 2 but with the funnel-like means 7 and the means defining the upstanding wall 9 removed, an inclined member 12 is

provided which forms a ramp down which coins may roll when the coins have been located on the ramp. The way in which this is accomplished will be described hereinafter. The upper part of the ramp extends partway across the upper region of the disc 8. The ramp inclines downwardly towards the right hand side of the apparatus (as viewed in Figures 2 and 3) from the top part of the periphery of the disc 8, and the ramp then merges into a second ramp arrangement 13 that extends downwardly towards the lower left hand corner of the apparatus. Various channels 14 extend downwardly from the ramp 13 leading to the chutes 6.

It is to be understood that a coin rolling down the ramp 12 will have the periphery of the coin engaging and rolling relative to the ramp while one flat face of the coin will effectively slide against an inclined face 15 of the apparatus that is substantially coplanar with the front face of the disc 8. A slot 16 is provided in this face 15 for purposes that will be described in greater detail hereinafter.

Provided on the disc 8 are a plurality of coin impellers 17. In the embodiment illustrated three such impellers are provided. The impellers are constituted by protrusions of elongate form. The impellers are equi-angularly spaced about the axis of the rotation of the disc and are located midway between the periphery of the disc and the centre of the disc. The impellers serve to stir up any coins present in the hopper as the disc 8 rotates.

Adjacent the periphery of the disc 8 are a plurality of evenly spaced coin catcher elements 18. Each coin catcher element 18 is inclined at a predetermined angle to a radial line joining the periphery of the disc 8 in the region of the coin catcher 18 to the centre of the disc. Each coin catcher element 18 is spring mounted so that, in its usual position, the coin catcher element protrudes above the planar surface of the disc, and the arrangement is such that, as the disc rotates and the coin catcher elements pass the ramp forming element 12 the coin catcher elements are moved against the spring bias that maintains them in the protruding position, and thus the coin catcher elements move to a retracted position in which the coin catcher elements are substantially flush with the front face of the disc 8. The coin catcher elements may thus readily pass behind the ramp forming element 12, the elements then again moving to the protruding position.

Each coin catcher element protrudes beyond the plane of the surface of the disc 8 by a distance that is less than or equal to the thickness of the thinnest coin that is to be handled by the apparatus.

Referring now to Figure 4 it will be appreciated that as the disc 8 rotates in a clockwise sense a coin 19 may become located within the "pocket" defined between a protruding coin catcher element 18 and the upstanding side wall 9 that surrounds the relevant part of the periphery of the disc 8. Since the disc 8 is inclined, and since the coin catcher element 18 protrudes beyond the face of the inclined disc by a distance which is, at the most, equal to the thickness of the thinnest coin that is being handled, it is not possible for two coins that are superimposed to be located in a single pocket.

It is conceivable that two relatively small coins 20, 21 may be effectively trapped in a single pocket, with the two coins being wedged in to the available space together, but the angle of inclination of each coin catcher element 18 is such that (having regard to the diameters of the coins being utilised) as the disc moves to a position, such as that shown in Figure 5, with the pocket containing the coins in an elevated position but not yet in alignment with the end of the ramp 12, the coin 21 would drop out of the pocket, whilst the coin 20 will remain in position.

With the arrangement described, as each pocket defined by a coin catcher element 18 and the upstanding side wall 9 reaches the end 22 of the ramp forming member 12 there will be a maximum of a single coin the pocket. The periphery of the coin engages the end of the ramp forming member 12, and as the disc continues to rotate the coin is gently moved along the first part of the ramp. Subsequently the coins may roll freely down the ramp, as the coin catcher elements become retracted into the surface of the disc 8 as the coin catcher elements move past the ramp 12, thus releasing the coins from the pockets. It will be appreciated that the end result is that a stream of coins 23, 24, 25 may roll down the ramp 5, but the successive coins will always be spaced apart by at least a minimum distance 26, since only one coin at a time will be delivered to the end of the ramp 12.

The coins move down the ramp 12 and are identified by various coin identifying means which will be described hereinafter. When a coin has been identified, the machine will effectively determine what will happen to the coin. If that coin is required in a coin bag attached to one of the chutes 6, the machine will permit the coin to roll down the ramp 12, and then down the ramp 13. When the coin is passing the top of the appropriate channel 14 leading to the corresponding chutes 6 a solenoid will operate to eject the coin forwardly from the ramp 13 into the appropriate chute 14. It is to be appreciated that such a solenoid may be operated to move a wedge-like element to extend across the path normally followed by coins rolling down the ramp 13, to cause the coin to be directed by the wedge-like element into the respective channel 14, or alternatively the solenoid may be operated to drive a pin forcibly into contact with the coin as it rolls down the second ramp 13, the movement of the pin being sufficient to eject the coin from the ramp 13 down the appropriate channel 14.

If the situation is that the coin is not required to be introduced into any bag present on a chute 6, for example if the bags relating to coins of that particular denomination have all been filled, or if the coin is identified as a coin that is not required to be introduced to a bag on any one of the chutes

(such a situation may arise if the detected coin is a foreign coin or a token) then a solenoid operated device 27 may be actuated to eject the coin from the ramp 12 back into the hopper 4. Again the solenoid device may comprise a wedge-like element that may be driven to a position in which it will deflect a coin rolling down the ramp back into the hopper, or it may be a pin driven with sufficient force to topple a coin from the ramp 12 into the hopper 4.

Figures 6 and 7 illustrate one coin identifying device that forms part of the presently described embodiment of the apparatus. The element that forms the front face 15 of the apparatus (as illustrated in Figures 2 and 3) is shown, and the uppermost surface of the ramp 12 is illustrated, as is the slot 16. An electric light source 28 is also shown. This electric light source is mounted within an appropriate housing 29 located on the interior of the front cover 3 of the apparatus (as shown in Figure 1). Light may leave the housing 29 through an aperture 30. A light sensitive device 31 is provided located behind the slot 16. The light sensitive device is an elongate light sensitive device in the vertical sense (as illustrated).

The light-sensitive device may be a linear array of photodiodes effectively arranged to provide a digital output signal, or may comprise a linear array or matrix of fibre optic elements each directed towards a separate photodiode, again providing an effective digital output signal. Alternatively again a linear photo-electric element may be utilised.

Figure 7 illustrates the arrangement in use. When a coin of a small diameter (such as coin 32 shown in solid lines) rolls down the ramp 12, a shadow of the coin is projected onto the light sensitive device 31, and the edge of the shadow impinges on the light sensitive device at point 33. When a slightly larger coin 34 (shown in phantom) rolls down the ramp, the shadow of the coin 34 impinges on the light sensitive device 31 at a point 35. Due to the geometry of the arrangement,the distance between the points 33 and 35 are much greater than the difference between the diameters of the coins. Thus using such a device it is possible readily to distinguish between coins of only slightly different diameters, since the difference in the diameters is amplified. Thus by arranging the light source on one side of the path to be followed by the coins to project an image of the coins onto an elongate photo-sensitive device located on the other side of the path to be followed by the coins, a very sensitive device is provided.

Figure 8 is a block diagram of a further coin identifying device that may be utilised in an embodiment of the present invention. The device illustrated in Figure 8 consists of a master crystal oscillator 36 the output of which is fed to a frequency divider 37 which provides an output signal in the range of 500 Hz to 5 KHz to a signal shaping circuit 38. The output of the signal shaping circuit 38 is connected to a node 39. A sensor driver 40 is connected to the node 39, and serves to direct the shaped signal to a coil 41 which has a "Q" (that is to say the ratio of the reactance to the effective resistance of the coil at the input frequency) of between 0.9 and 1.1. The sensor coil 41 is located adjacent the ramp 12 as described above, so that a coin 42 moving down the ramp passes adjacent the coil. The coil then effectively becomes "loaded" and the "Q" of the coil will change. This results in a change of the phase of the signal present at the output 43 of the sensor driver.

The output of the sensor driver is connected to a phase multiplier 44 which has a second input connected to the node 39.

The phase multiplier 44 serves to multiply by two the phase shift between the output of the sensor driver and the reference frequency present on the node 39. The output of the phase multiplier 44 may be connected to one or more successive phase multipliers (only one such successive phase multiplier being illustrated in phantom as phase multiplier 45). Thus the signal present on the eventual output line 46 will be a signal that has a phase shift equal to an even multiple of the phase shift present at the output of the sensor driver relative to the signal present at the node point 39.

The node point 39 is also connected to a phase correction circuit 47. The phase correction circuit 47 is adjusted so that the phase on the output 48 of the phase correction circuit 47 is precisely the same as the phase on the output 43 of the sensor driver circuit 40 when the coil 41 is unloaded. The output 48 of the phase correction circuit 47 is connected to a phase multiplier 49 that corresponds with the phase multiplier 44, and the output of the phase multiplier 49 is connected to a series of one or more phase multipliers (only one phase multiplier 50 being shown in phantom) corresponding to the phase multiplier or multipliers 45. The output 51 of the phase multiplier 50 is fed to the phase comparator. When the coil 41 is unloaded, that is to say when no coin is present adjacent the coil 41, the signals present on the lines 46 and 51 will be precisely in phase. When a coin 42 is located adjacent the coil the phase on the line 46 will shift relative to the pahse on the line 51. Although there will only be a very slight phase shift at the output 43 of the sensor driver 40, by virtue of the action of the phase multipliers there will be a significant phase shift between the signals present on lines 46 and 51. The magnitude of the phase shift will depend upon the size of the coin 42, and the material utilised to fabricate the coin 42. Thus, from the size of the phase shift it is possible to determine the denomination of the coin 42. The output of the phase comparator, which is indicative of the phase shift is provided in the form of a count present on the counter 53 which is driven by a very high frequency signal supplied directly from the oscillator 36. The number on the counter made available on an appropriate digital latch.

The phase multiplier 44 may comprise a cascaded chain of linear multipliers (e.g. type MC 1594L or equivalent devices). Each stage in the

cascade will double the phase difference, and will also double the frequency of the signal. Alternatively a phase-locked loop which uses a digital edge-triggered phase comparator (supplied complete in device CD 4046) may be adopted.

In the above described circuit all signals are digitally derived from the single high frequency crystal oscillator to minimise any effects caused by changes in temperature.

CLAIMS

1. A coin handling apparatus, said coin handling apparatus comprising means defining a substantially planar inclined face, at least part of the means adjacent the periphery of the face being movable in a rotary manner within the plane of the face elements being provided, mounted on the said means, protruding above the said plane, there being a wall extending substantially perpendicularly to said plane immediately adjacent the outer periphery of said means, at least in a region extending past a portion of the lower part of the periphery, said movable means, elements and wall co-operating to define recesses each dimensioned to accommodate a coin, the apparatus further comprising means to direct a mass of coins to a position adjacent the lower portion of said movable means and means defining a transportation path to be followed by said coins, the arrangement being such that when the movable means move coins can become located within said recesses to be moved in synchronism with the movable means to a position in which the coins leave the recesses and follow said predetermined transportation path.

2. An apparatus according to Claim 1, wherein the transportation path comprises a downwardly inclined ramp, the arrangement being such that a coin present in a recess will leave the recess when the recess has moved to a predetermined position, the coin then rolling down the ramp.

3. An apparatus according to Claim 1 or 2, wherein the said means comprises an inclined disc.

4. An apparatus according to Claim 3, wherein the entire disc is rotatable.

5. An apparatus according to any one of the preceding claims, wherein the ramp extends across part of the upper periphery of the said inclined face, and wherein each said element is resiliently mounted on said movable means to be movable between an operative projecting position and a retracted position, each element moving to a retracted position as it moves past the said ramp.

6. An apparatus according to any one of the preceding claims, wherein each said element is on the operative position the element protrudes beyond the said plane by a distance which is less than or equal to the thickness of the thinnest coin to be handled.

7. An apparatus according to any one of the preceding claims, wherein each said element comprises a substantially linear element, one end of the element being located substantially adjacent the periphery of the movable means, the axis of the element being inclined forwardly (in the sense of movement of the movable means) of the line connecting the end of the element adjacent the periphery of the movable means and the centre of movement of the movable means.

8. An apparatus according to any one of the preceding claims wherein the arrangement is such that when each said recess reaches the commencement of the said transportation path only one coin can be accommodated within the recess.

9. An apparatus according to any one of the preceding claims, wherein the means for directing the coins adjacent the rotating member comprise a hopper.

10. An apparatus according to any one of the preceding claims, wherein means are provided for determining the identity of any coin moving along said coin transportation path, the apparatus further comprising means to determine the eventual destination of a coin once its identity has been established.

11. A coin handling apparatus comprising means for directing coins from a mass of coins to follow a predetermined coin transportation path, means adapted to identify a coin travelling along the coin transportation path, and means for returning a coin from the coin transportation path to said mass of coins, if the coin is not required for subsequent handling by the machine.

12. An apparatus according to Claim 11, wherein the coin transportation path comprises an inclined ramp and the means for returning a coin to a mass of coins it comprises a solenoid operated device adapted to return a coin to a hopper or the like which is located below said ramp.

13. A coin identifying apparatus, said coin identifying apparatus comprising means defining a coin transportation path along which coins are intended to move, a light source located on one side of the coin transportation path and an elongate photosensitive device located on the other side of the coin transportation path, but spaced away from the path, the arrangement being such that an image of each coin is projected onto the photosensitive device as the coin moves down the coin transportation path.

14. An apparatus according to Claim 13, wherein the light sensitive device is a linear array of photodiodes or a linear array or matrix of fibre optic elements each directed towards a separate photodiode.

15. A coin identifying apparatus, said coin identifying apparatus comprising a coil located adjacent a path followed by coins to be identified, means for applying a signal of an appropriate frequency to the coil, means for multiplying a phase shift applied to said signal by the coil when a coin is located adjacent the coil and means for determining the magnitude of the multiplied phase shift.

16. A coin identifying apparatus according to Claim 15, wherein the apparatus comprises

means for supplying a shaped signal to an appropriate circuit driving the coil and to a phase correction circuit, the output of the phase correction circuit and the circuit driving the coil being in phase when no coin is present adjacent the coil, the output of the phase correction circuit and the driver circuit being phase multiplied by a predetermined number of times, the phase multiplied signals being fed to a phase comparator.

17. A coin handling apparatus substantially as herein described with reference to and as shown, in the accompanying drawings.

18. A coin identifying apparatus substantially as herein described with reference to and as shown in Figures 6 and 7 of the accompanying drawings.

19. A coin identifying apparatus substantially as herein described with reference to and as shown in Figure 8 of the accompanying drawings.

20. Any novel feature or combination of features disclosed herein.

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